DEC STD 102-4 Environmental Standard for Computers and Peripherals - Product Acoustic Noise Measurement

DOCUMENT IDENTIFIER: A-DS-EL00102-04-0000 Rev BX03, 22-Nov-1989

ABSTRACT: This standard specifies uniform procedures for measuring and reporting acoustic noise emission from Digital products.

APPLICABILITY: These requirements apply to all Digital systems or hardware products that emit acoustic noise (sound) in the frequency range 89.1 Hz to 22.4 kHz. This

STATUS: FOR REVIEW ONLY

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DOCUMENT IDENTIFIER: A-DS-EL00102-04-0000 Rev BX03, 22-Nov-1989

	Rev A,	21-Jul-1983
Document Management Category:	Acoustics (HRA)	
Responsible Department:	Product Acoustics Group	
Responsible Person:	Bob Lotz	
SMC Writer:	Ann Leger	

APPROVAL: This document has not yet been approved.

Unsigned Review Copy

Bob Lotz - Product Acoustics Group

Unsigned Review Copy

Eric Williams - Standards Process Manager

Direct requests for further information to:

Larry Wittig
Use $ VTX ELF for the latest location information.

Use VTX SMC to order copies of this document from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

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1 INTRODUCTION

1.1 PURPOSE

This section of DEC STD 102 establishes:

a. The points in the development process where product acoustical testing is required and where such testing is recommended, but not required.

b. Uniform acoustical test procedures that are compatible with appropriate national and international standards and industry practices.

c. Sufficient data logging, record retention, and reporting requirements to facilitate transmission of product acoustical data, internal and external to Digital.

d. The responsibilities of the various parties involved in originating the noise measurement, conducting the test, maintaining files, and using the data. See Appendix A.

1.1.1 Levels of Detail for General Readers and for Test Engineers

For the reasons outlined below, two levels of detail are provided in this document.

Digital products that emit acoustic noise must be tested in accordance with the requirements of the International Organization for Standardization (ISO) 7779 and 9295 when applicable, as modified by the differences listed herein. The ISO standard is very long, and of interest primarily to those actually conducting acoustical tests. It is also subject to occasional revision. Some Digital-unique requirements and guidance must be added to the requirements of ISO 7779 and 9295.

NOTE ON ISO 7779 AND 9295

ISO standard 7779: 1988 (E) is the most complete, pre-eminent and current standard on measurement of acoustic noise from computers and business equipment. ISO 9295 is a complementary standard that covers the 16kHz octave band. Because ISO 9295 is limited to this band, and measurements in accordance with it are not always required, this document for brevity will generally only refer to ISO 7779.

Except as noted under "Referenced Documents," DEC STD 102-4 is, and will continue to be, in conformance with ISO 7779 as well as ANSI S12.10.

Melding the ISO 7779 and the Digital-unique requirements into a single massive section of this Digital Standard would cause considerable problems for its use and maintenance. General users would be confronted with far more physical bulk and information than they need. Revisions to the ISO document, even trivial ones, would require tedious revisions to the Digital Standard for continued compatability. To avoid such undesirable complexity and inefficiency, DEC STD 102-4 has been structured to achieve two purposes, intended for two categories of reader:

Headings 1 through 3 provides all readers with a listing of the procedural requirements of DEC STD 102-4 and a summary of the testing requirements. These headings highlight the ISO requirements and introduce some Digital-unique information.

Heading 4 provides the acoustical test engineer, and others who are interested in details, with a "difference list" of Digital-unique requirements that augment ISO 7779. These readers would be advised to obtain a clean copy of ISO 7779 and mark it up according to this difference list. Alternatively they may obtain from the Product Acoustics Group a copy of ISO 7779 that is annotated with the additional Digital requirements of subhead 4.

This section of DEC STD 102 incorporates, by reference, the entirety of ISO 7779 and ISO 9295 as modified by the differences listed in subhead 4.

1.2 SCOPE

1.2.1 Products

These requirements apply to all Digital systems or hardware products that emit acoustic noise (sound) in the frequency range 89.1 Hz to 22.4 KHz. This includes hardware products having moving mechanical parts (such as: fans, motors, solenoids, printing and paper handling mechanisms, keyboards, disk or tape drive components) as well as those having electromagnetic/magnetostrictive sources of noise (such as: power supplies, visual display units).

If it is not clear whether or not a product needs to be tested per the above guidelines, the Responsible Engineer should contact the standard owner for a determination.

1.2.2 People

Requirements apply to Responsible Engineers, Design Review Committees, Product Business Units, Manufacturing, the Field Organization, Corporate Marketing Services, and the Product Acoustics Group for hardware products that emit noise.

1.2.3 Timing

Several recommendations address very early phases of product development, during design concept formation, prior to Phase 0.

Requirements address testing of engineering prototypes prior to product announcement and testing of production units. Planning for these tests and designing to meet requirements of *DEC STD 104-0 Product Acoustic Noise Limits*, should begin during Phase 0.

1.2.4 Phase-In

The requirement to test applies to all new products, and all existing products that have not been tested and are not planned to be discontinued within one year of the date of approval of this section, except for products that do not emit acoustic noise per subhead 1.2.1.

1.2.5 Exclusions

The procedures for calculation of sound level or other designated values from measurements made on one or more invididual units are not covered by this document. For further information on this topic, contact Product Acoustics Group. The values of the acoustic noise emission limits for Digital hardware products are confidential to Digital. That information is published in a separate document, DEC STD 104-0, which is classified Digital Internal Use Only.

1.3 OVERVIEW

After introductory material in subhead 1, test unit selection and setup requirements are described in subhead 2. Subhead 3 is a description for the general reader of the test procedure and reporting requirements. It may be considered as an extended summary of subhead 4 and ISO 7779, and should be used in that spirit. The actual, detailed requirements for testing and reporting are given in subhead 4, by reference to ISO 7779 and by explicitly stating further Digital requirements beyond those of subheads 1 and 2 and of the ISO document.

The test procedures require use of qualified acoustical test rooms (see Appendix A) and precision instrumentation with calibration traceable to the National Bureau of Standards. These procedures cover: measurement of acoustic noise; logging of data; retention of records; and requirements for reporting.

1.4 RESPONSIBILITIES

1.4.1 Responsible Engineer

The Responsible Engineer (as named in the Engineering Long Range Plan or other document) is responsible for ensuring that:

a. The product design provides the capability for exercising the product in idle and operating modes that are in accordance with this standard.

b. A test plan is developed as outlined under heading 3 and submitted to Product Acoustics Group for approval. The test team is alerted in advance if it is believed that test modes specified in ISO 7779 are inappropriate for a particular product.

NOTE

The test plan may be jointly developed by the Responsible Engineer and the Product Acoustics Group.

c. The product is tested, and that the test results are reported, in accordance with this standard.

d. The effect of product changes subsequent to acoustic noise emission tests are evaluated and re-testing is performed after the changes are made, if necessary.

e. Acoustic information is provided for marketing and sales materials, and is from tests performed and reported in accordance with this standard.

f. Final product specifications are consistent with test data.

g. Sufficient funding and other resources are provided to support all of the above activities.

h. Information on the product's intended end-use environment as described in DEC STD 104-0 is submitted to the Product Acoustics Group.

i. Support equipment and personnel necessary to operate the product being tested are provided at the time of the test.

If it is necessary that the product design or testing deviate from the requirements of this standard, the Responsible Engineer is responsible for obtaining the waiver. See DEC STD 066-2.

1.4.2 Design Review Committee

Design Review Committee responsibilities are specified in *EL-CP356-00 Corporate Phase Review Process Guide.*

1.4.3 Product Business Units, Systems Program Offices and Field Organization

Acoustical claims and data may be used in product promotional material only if obtained and reported in accordance with this standard. Data in such promotional material should be in accordance with subhead 3.5.3, items b and c. It is strongly recommended that individual field requests for acoustic noise data on Digital products be answered by obtaining official, updated data on specific product/variations from the Product Acoustics Group.

1.4.4 Corporate Marketing Services, and Other Groups That Publish Sales literature

Acoustical claims and data may be used in product promotional material only if obtained and reported in accordance with this standard. Refer to subhead 3.5.3.

1.4.5 Product Acoustics Group

The Product Acoustics Group is responsible for:

a. Maintaining this standard and assisting users in its interpretation and use;

b. Approving all acoustic noise measurement test plans;

c. Providing test services in accordance with the standard, when funded by Product Development or other groups;

d. Approving, retaining, and archiving all test result records.

e. Determining noise designation values suitable for use by marketing as described in subhead 3.5.3 for Digital products, based on items b, c and d, and for maintaining corporate files on designated values.

f. Providing appropriate product acoustic noise emission data, upon request, to marketing or other groups for planning standard systems or publishing in product technical documentation, or responding to customer requests.

g. Reporting on the pass/fail status of the product with respect to the limits of DEC STD 104.

NOTE

In addition to acoustical testing near the completion of product development and early in manufacture, the Product Acoustics Group provides contracted acoustical design engineering assistance/support to Product Development Teams. The preferred procedure is to assign a Product Acoustics Group engineer to work as a part of the development team from product mechanical design concept inception onward (at or before start of Phase 0). In such cases, some of the responsibilities of the Responsible Engineer in subhead 1.4.1 may be delegated (by mutual agreement) to the Product Acoustics Group. If packaging concepts at the "sketch and cardboard" stage are good acoustically, and if attention to acoustics is continued throughout the remainder of design, then the final product is most likely to reach its acoustical goal.

2 UNITS REQUIRED FOR TESTING

There are three separate stages of testing specified in this standard; design/development testing, design assurance testing, and subsequent testing of production units. Each stage has its own requirements for types and numbers of test units as discussed in the remainder of this subhead.

2.1 DESIGN/DEVELOPMENT TESTING

During engineering design and development, tests that are in accordance with this standard, and/or that incorporate other test methods, may be performed to diagnose acoustical problems and to develop and evaluate candidate acoustical design elements. Although strongly recommended as a continuing part of product development, beginning at inception of design, such testing is not formally required by this standard. The selection of test unit(s) is at the discretion of the Responsible Engineer or those to whom responsibility is delegated.

An "early look" test of the first mechanical/thermal test unit is particularly recommended for any product that has not had an acoustic noise control engineer providing design input.

2.2 ENGINEERING DESIGN ASSURANCE TESTING

2.2.1 Purpose Of Tests

First, these tests are required to document the acoustic noise level emission produced by functional engineering units for comparison with design goals and DEC STD 104 acoustical limits. Second, these tests provide engineering with information that is of continued use in new product design. Third, they provide product business units and the field organization with advance information as to product compatibility with customer environments, and with emission values that may be used for product specifications and customer marketing.

One additional purpose of these tests is to determine the range of likely product noise emission due to noise differences among interchangeable parts. Therefore, consideration should be given to selecting product samples that have interchangable parts, for example fans from different suppliers.

2.2.2 Status of Test Units

These tests shall be conducted near completion of engineering design with units that have noise emitting components that are the same as they will be in release level units. Components whose noise emissions are speed dependent, such as fans, shall be run at the same speed as they will be run in release units. These units are referred to as DVT (Design Verification Testing) units which are also subject to other Digital standard tests in accordance with the Digital Qualification Process Manual (A-MN-ELEN522-00-0). However, the term DVT does not have a unique meaning to all development groups, so for cases that are not clear, contact the Product Acoustics Group.

Since acoustic testing is non-destructive, it is recommended, but not required, that the test units be tested for acoustics before they are subjected to other tests such as shock and vibration.

2.2.3 Timing; Number of Units

Prior to product announcement, one sample shall be randomly drawn from units in new condition built essentially as the product will be. This unit shall be tested in accordance with this standard and shall pass the requirements of DEC STD 104-0.

Prior to first customer ship, three additional randomly selected samples shall be drawn and tested. If there have been no changes that affect acoustics since the "product announcement" unit was tested, then two units are sufficient. These three units shall pass the requirements of DEC STD 104-0. If a products intends to announce and ship simultaneously, a single test series with three units suffices.

When the standard deviation of the products tested exceed three decibels, testing of additional units is strongly recommended. For low product run products scheduled for a single customer the number of units to be tested may be reduced to one. In this situation, the Responsible Engineer should contact the owner of this standard for a determination of the number, Additional units are recommended if noise emissions are critical.

2.2.4 Selection Of Test Units

2.2.4.1 Object and Model Number Coverage

The object of specifying or selecting test units for these and subsequent tests is to obtain accurate test results corresponding to the latest engineering design or manufactured product while (1) minimizing the costs of test unit fabrication, modification, and testing and (2) maximizing applicability of test results to product variations. All model numbers (that is, each line item on the Option/Module List except Status Codes 0, 6, 7) must be covered either by direct testing, by substitution as described under the following subhead, by calculation using direct testing or substitute data, or by test waivers. (The calculation method must receive prior approval.) Specifically, products for which fans, blowers, or other electromechanical components are driven at line frequency, and are significant sources of acoustic noise, it is necessary to test both 50-Hz and 60-Hz versions of the product.

2.2.4.2 Substitution of Test Results from Another Product Variation

The test results of Product A may be used in place of tests on Product B for comparison to DEC STD 104 limits if Product B can be developed from Product A by any of the following:

a. Deletions of electromechanical parts.

b. Additions to Product A's enclosure.

c. Changes to electronic components and parts, except electromagnetic components, such as transformers and inductors.

The intent of the above stipulations is to be sure that the noise emissions of Product B will not be greater than those tested on Product A. When it is believed to be significantly quieter, however, Product B should be tested directly to establish lower quotable values for marketing and product development information.

It is recommended that the Responsible Engineer arrange early discussions with the Product Acoustic Group to identify appropriate test unit(s) and to finalize product exercise modes prior to development of a test plan. In accordance with the standard waiver process, a formal waiver of testing is required for any product or variation that is neither tested directly nor covered by appropriate test units.

NOTE

If products tested at this phase in the development cycle do not meet DEC STD 104 limits, it is frequently impractical to introduce the engineering redesign and changes that would result in a compliant product, although some small improvement can often be obtained. Usually acoustical problems cannot be remedied satisfactorily by any simple addition of acoustical materials to an otherwise completed design.

2.3 SUBSEQUENT TESTING OF PRODUCTION UNITS

2.3.1 Purpose of Tests

Product acoustic noise emission designation values derived from the tests described in subhead 2.2 are used in proposals, contracts, and product spec sheets. These levels are also quoted to regulatory agencies and end users. It is important that the product continues to meet DEC STD 104-0 and that actual product emissions continue to be consistent with or better than designation values.

Changes to the product design after the design assurance testing, for example, to simplify production or reduce product cost, may change product acoustic emissions. Examples are changes in: clearances near fans, mountings of fans and disk drives, part numbers of moving mechanical parts, materials used within the enclosure, and setup of electromechanical parts, for example, print head gap.

The purpose of tests of production units is to ensure that the product emissions continue to meet DEC STD 104-0 and continue to be consistent with (or better than) the designation values.

2.3.2 Selection Of Test Units; Test Waivers

Subsequent to the tests required by subhead 2.2, if changes as detailed in subhead 2.3.1 are made to the design or manufacture of the product, a sample size of at least one shall be selected and tested, and shall pass the requirements of DEC STD 104-0 as described in that document. If the one sample tested does not pass the requirements of DEC STD 104-0, of if the measured level differs significantly from the designation values, the responsible engineer should consult with the Product Acoustics Group concerning the possibility of additional testing.

The substitution provisions of DEC STD 102-4, subhead 2.2.2, may be used to avoid testing where changes will not result in an increase in product acoustic noise emission. Responsibility to identify changes, seek waivers, or obtain retesting rests with the Responsible Engineer throughout the life of the product.

3 INTRODUCTION AND SUMMARY OF TEST PROCEDURE AND REPORTING REQUIREMENTS

3.1 USE OF THIS SUBHEAD

For all readers, this introductory material is intended to be an overview. For those concerned with the details of testing and reporting, this material also serves as an introduction and summary to the material under heading 4. Some material is covered only under this subhead, therefore it should be read carefully. However, the majority of material is covered again under subhead 4 and in ISO 7779 in greater detail. For either reader, if there is conflict between the abbreviated material under this subhead and other material in this standard, including referenced standards such as ISO 7779, the other material shall govern.

3.2 CONFIGURATION OF EQUIPMENT UNDER TEST

Prior to testing, the Responsible Engineer or designate shall provide a detailed description of the equipment to be tested in a test plan (Appendix B) or other documentation to the person responsible for conducting the test. If the test will not take place at the product acoustics lab, a copy shall still be provided to the Product Acoustics Group. The equipment under test shall be in good working order and in its normal operating condition, with all covers, doors, and other enclosure parts such as cable opening cover plates in place.

Where practicable, coupled units should be tested coupled. However, if the equipment under test consists of several frames (cabinets) bolted together and is too large for testing, the frames (cabinets) may be tested separately. In such cases, additional covers, which are acoustically comparable to other covers already on the equipment, shall be installed where required to complete the enclosure of the frame (cabinet).

3.3 EQUIPMENT INSTALLATION AND OPERATION

3.3.1 Governing Requirements

The objective of the installation and operation specifications is to provide uniform conditions closely related to the intended use of the product. Annex C to ISO 7779 provides extremely specific installation and operation instructions for most types of computer equipment. These specific instructions are to be followed. However, if they are contrary to the foregoing objective (that is, reasonable correspondence with intended use), then an additional mode or modes closely related to intended use shall be defined, tested, and documented. In this case, applicable sections in the body of ISO 7779 provide general guidance. Test documentation must be complete enough that the test may be replicated solely by reference to the documentation.

3.3.2 Summary of Installation Requirements

Rack mounted equipment is installed in a complete enclosure. The enclosure is then treated as either floor-standing or table-top equipment, as appropriate. Floor-standing equipment is installed on the floor.

Table-top equipment is installed on top of a standard test table for measurement of sound pressure level at bystander and operator positions. For determination of sound power, table-top equipment is generally installed on the floor. There are a few exceptions to this, such as a teleprinter that picks up paper from the floor or stacks it there.

Subassemblies, including rack mountable equipment and storage devices that are to be incorporated into larger assemblies, are not covered by ISO 7779 for sound pressure level measurement. Digital, however, specifies that subassemblies intended for use in desk-top products be mounted on temporary isolator feet that hold the subassembly 1 to 2 cm above the surface of the standard test table and measured for sound pressure level as table-top equipment. If the end-use of the subassembly will be in a product that has a keyboard, the front operator and front bystander microphone positions should allow an extra 0.25 m in front of the subassemblies. If a larger keyboard will be used for the product, the distance shall be increased to accommodate that keyboard and that distance shall be noted in the test file. The affected subassemblies include primarily small storage devices, such as RD32, RX33, TK70. Larger subassemblies not intended for use in desk-top or table-top products, are to be mounted 0.25m above the floor on vibration isolators for sound pressure level measurements. This would include devices such as RA90. For determination of sound power, all subassemblies are installed 0.25m above the floor, supported on vibration isolators.

3.3.3 Adjustments

Any adjustments that are required by the installation specifications to align panels, level cabinets, remove shipping blocks and bolts, and so forth, shall be made prior to testing. Specifically, the unit must be taken off its shipping skid or pallet.

3.3.4 Auxiliary Equipment

Care shall be taken to ensure that any electrical conduits, piping, or air ducts connected to the equipment do not radiate significant amounts of sound energy into the test room. If practical, all auxiliary equipment necessary for the operation of the equipment under test shall be located outside the test room and the test room shall be cleared of all objects that may interfere with the measurements.

3.3.5 Summary of Operating Requirements

3.3.5.1 General

a. After suitable warmup, equipment is tested in idle mode and in at least one operating mode.

b. Equipment that requires manual operation to perform its intended function (e.g., keyboards) is tested with either a human operator or a robot operator as described in Appendix A of ECMA 74.

c. As stated in ISO 7779 paragraph 5.5.3, "If the equipment being tested produces attention signals, for example, tones or bells, such intermittent sound shall not be included in an operating mode. During the acoustical evaluation in the operating mode(s), such attention signals shall be inoperative."

d. Uniform acoustical test installations and operating conditions are specified in ISO 7779 appendixes. Test patterns generated by diagnostic programs developed for other reasons, for example reliability testing, usually do not provide acoustical emissions typical of customer use.

e. For reader convenience, a summary of the ISO 7779 operating requirements is provided below. Copies of the detailed operating requirements for a specific product from ISO 7779 modified with Digital requirements and procedures may be obtained from the Product Acoustics Group.

CAUTION

Do *not* use these summarized operating requirements for actual testing. Instead, use subhead 4 of this standard and ISO 7779.

3.3.5.2 Summary of Specific Operating Requirements by Product Type Keyboards

— Idle: Unit powered on.

— Operating: Data Entry for alphanumeric - continuous manual (or robot) typing "etnaiv etnaiv..." and so on, at five characters per second, acoustic feedback (key click) on minimum volume setting (generally "off").

Printers and Teleprinters

— Idle: paper in position, unit on.

— Operating: Data Entry - (teleprinter only) same as keyboards.

— Operating: Print - single part paper, double line spacing; specified pseudo-random pattern at rated speed (printers and teleprinters).

Magnetic Tape Storage Units

— Idle Unloaded: Tape not loaded, but power on.

— Idle Loaded: Tape loaded, power on, unit ready to respond to control line commands.

— Operating: Read/Write mode: start, read or write, stop per specified timing formula.

— Operating: Streaming mode: (if applicable) forward run while writing.

Magnetic Disk Storage Units - (Rigid and Flexible Disks)

— Idle: Disk(s) loaded, unit on and ready.

— Operating: Sequential read/write (flexible disks only).

— Operating: Random read/write (rigid and flexible).

Visual Display Units

— Idle: Unit on, full character set displayed, all screen positions used.

— Operating: for units with keyboards, same as for keyboards.

Electronic Units (CPUs, communication link boxes, controllers, and so forth)

— Idle: Steady state operation with normal load on all cooling devices, power supplies, and distributed power supply elements. No data operations are required. For electronic units the idle and operating modes are deemed to be the same.

Personal Computers and Workstations

— Idle: Power on, air moving devices running, disk drives in idle mode, a full character set on the screen, and all other devices idling.

— Operating: Equipment with disk drives as C9, equipment with magnetic tape as C7, and equipment with built-in printers as C3.

Optical Disk Storage Devices

— Idle: Disk loaded, power on, unit ready to receive and respond to line commands.

— Operating: Random read/write or sequential read/write.

Noise Reduction Products

— Idle: Same as base product.

— Operating: Same as base product.

3.4 MEASUREMENTS

Two types of noise emission measurements are required for each operating and idle mode of the equipment under test: (a) sound power level and (b) sound pressure level. Each type of emission measurement has a normal frequency range (89.1Hz to 11.2kHz) method and a high frequency method (11.2kHz to 22.4kHz).

For determination of A-weighted levels, DEC STD 102-4 excludes the measurements of sound power and sound pressure levels in the 16kHz octave band (11.2 to 22.4kHz) in accordance with sections 5, 6 and 7 of ISO 7779. For this octave band only, two screening tests shall be performed in accordance with the DEC STD 102-4 addition of section 7.7.7 to ISO 7779, one for sound power and one for sound pressure. If the screening tests indicates the presence of high frequency sound energy, then (a) a high frequency sound pressure level tone analysis shall be conducted in accordance with the remaining section 7.7.7, and/or (b) the sound power level in the 16kHz band shall be determined in accordance with ISO 9295.

3.4.1 Sound Power Level Determinations

3.4.1.1 Noise Power Emission Level - 89.1 Hz to 11.2 kHz

Noise Power Emission Level, expressed in bels relative to (re) 1 pW, is the A-weighted acoustic power in the frequency range 89.1 Hz to 11.2 kHz that the equipment contributes to the environment in which it operates. Digital also requires octave or one-third octave band measurement of the sound power in this frequency range. A reverberation room method and a hemi-anechoic room method for determining noise power emission level are given in detail in ISO 7779. One or the other method shall be used. Either is acceptable in accordance with this Digital standard, provided the facilities, instrumentation, procedures, and other factors are in strict accordance with ISO 7779, as modified by heading 4 of this standard. For products whose sound level is dependent on ambient temperature, this test shall be conducted at 23 ± 1° C. An additional sound power level test or analysis is required for operation at 27 ± 1° C.

3.4.1.2 Sound Power Level - 11.2 kHz to 22.4 kHz

In the 16kHz octave band, methods for determination of emitted sound power are different and more complex than methods for lower frequency sound.

A screening test shall be performed per DEC STD 102-4 addition of section 7.7.7 to ISO 7779. If this test indicates the presence of high frequency sound energy, Digital requires determination of sound power level in the 16 kHz octave band (11.2 kHz to 22.4 kHz) and its constituent one-third octave bands expressed in decibels relative to (re) 1 pW.

This yields the acoustic power in this frequency range that the equipment contributes to its environment. A reverberation room method and several hemi-anechoic room methods are given in detail in ISO 9295, which shall be followed. In addition, a narrow band analysis shall be performed to determine the frequencies of any discrete tones.

3.4.2 Sound Pressure Level Measurements

Sound pressure level is the second type of required noise emission measurement. This quantity is analyzed to yield several forms of sound pressure level data at a defined point or region in space relative to the equipment, when the equipment is in an acoustics laboratory that excludes reflections (except from the floor) and other sounds.

3.4.2.1 Sound Pressure Level - 89.1 Hz to 11.2 kHz

All modes are measured at the front operator position and at the bystander positions at front, rear, right and left sides. Machines larger than 2m in any horizontal dimension require additional positions. See ISO 7779.

Four distinct sound pressure analyses are required in this frequency range, and a fifth is recommended:

1. Perhaps the best known sound pressure metric is A-weighted Sound Pressure Level, LpA. This is determined for each defined mode of operation.
2. A-weighted Impulse Sound Pressure Level LpAI is determined by time averaging the impulse response of the sound level meter according to a specific logarithmic equation. This is done only at the operator position or (if not operator attended) at the bystander position having the highest LpA. If the noise emissions are perceived to include impulsive sound and the difference LpAI - LpA exceeds 3 dB, the mode is considered impulsive in accordance with ISO 7779, and so rated.
3. Frequency analysis is performed to determine whether any audible discrete tones, present in the spectrum, are to be considered prominent. This analysis is performed on the signal from the same microphone as the test for impulsive noise. The detailed procedure compares the spectral peak produced by a tone with the broadband noise present in the spectrum near the tone. If the difference exceeds the criterion, the mode is considered to have a prominent discrete tone at that frequency in accordance with a Digital-modified version of the ISO 7779 procedure.
4. Digital also requires measurement of octave or one-third octave band sound pressure levels.
5. An analysis with a constant percentage bandwidth filter no wider than 1/10 octave is recommended at the loudest bystander position, except if operator attended, at the operator position.

This standard also requires that a tape recording of the sound pressure signal be made at loudest bystander, except if operator attended, at the operator position. See the modifications to Sec. 7.9.4.

3.4.2.2 Sound Pressure Level - 11.2 kHz to 22.4 kHz

The procedure for measuring Lp in this frequency range is unique to Digital. All modes that emit significant noise in this octave band in accordance with the screening test of section 7.7.7 are measured by scanning with the microphone in the vicinity of the operator position or, if no operator position is defined, in the vicinity of the bystander position with the highest LpA. Frequency analysis is performed to determine the frequency and sound pressure level of acoustic energy in this band. Details of this procedure are given in subhead 4.

3.5 REPORTING AND LOGGING OF DATA

3.5.1 To Product Acoustics Group

Subhead 4 specifies complete requirements on data to be recorded by the acoustical test team and submitted for approval and filing in an archive of all formal test data maintained by the Product Acoustics Group.

3.5.2 To Test Requestor

A subset of the archival data is reported to the person requesting the test. The following information shall be reported:

a. Test location and personnel

b. Operating modes tested

c. LNPE and LpA and one-third octave band or octave band levels obtained for each mode. LpA is reported for the operator position, if defined. Otherwise LpA is reported as the spatial energy mean of the bystander positions in accordance with Eq (10), of ISO 7779. If high frequency noise is present, the sound power level, sound pressure level, and a frequency analysis of the sound energy.

d. Whether prominent discrete tones or impulsive noise are present in each mode

3.5.3 To Marketing Groups, Sales Representatives

The following information shall be reported by the Product Acoustics Group on announced products upon request by any Digital employee, provided the data were obtained and submitted for archiving in accordance with this standard.

a. The name(s) and model number(s) of the equipment concerned

b. Arithmetic Average Noise Power Emission Level (LNPE) for the idle and operating modes, and a description of the appropriate ISO 7779 testing procedures (for example, ISO 7779 - Section III) of the units tested.

c. The arithmetic linear average of the A-weighted Sound Pressure Level (LpA) for the idle and operating modes for the units tested at the operator position, if operator attended otherwise, the arithmetic average of the acoustic energy average of the LpA's at the bystander positions and description of the ISO testing procedure that was used to make the measurements (per ISO 7779 - Section 7).

Additional information can also be provided if appropriate.

3.5.4 To DEC Sweden

The information required by the Swedish standard Statskontoret 26:1 shall be reported quarterly by the Product Acoustics Group to DEC Sweden provided the data required by this Swedish standard were obtained and submitted for archiving.

3.5.5 Issuance of Label Values Not Covered

Determination and reporting of label values for compliance with labeling regulations is not covered in this subhead. For guidance, consult the Product Acoustics Group.

4 DETAILED TEST PROCEDURE AND REPORTING REQUIREMENTS

Digital products must be tested in accordance with the requirements of ISO 7779, supplemented with Digital-unique requirements. This heading provides the acoustical test engineer and others who are interested with details of the Digital-unique requirements not already covered under headings 1, 2 and 3. A copy of ISO 7779, annotated with additional Digital requirements, may be obtained from the Product Acoustics Group.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 1.2	Field of Application - In the event of conflict, subheads 1.1 and 1.2 of DEC STD 102-4 prevail. Field of Application - Insert at the end of last paragraph "using ISO 7574. **CAUTION** **Because A-weighted sound pressure levels determined in accordance with this standard are not imission values, they should not be compared to imission (workplace) limits."**
ISO 2	Add between heading and first sentence: "This material is necessary but not sufficient for conformance with this Digital standard. DEC STD 102-4 requires measurements of sound power level and sound pressure level. The power level measurement may be made by the reverberation room procedure in section 5, or by the free field method described in section 6. The sound pressure level measurement shall be made at the operator and bystander positions in accordance with section 7. In addition, as determined by the screening procedures in Digital unique section 7.7.7, a high frequency tone pressure level measurement and/or high frequency power level measurement may be required. For products whose sound level is dependent on ambient temperature (e.g., products with fan speed control), this test shall be conducted at 23° C, and an additional sound power level test in accordance with sections 5 or 6 is required at 27° C.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 4	Definitions - This material is supplemented and partially duplicated by Glossary material in this Digital standard, which governs in the event of conflict. Therefore delete the following sections of ISO 7779. 4.2 bystander 4.3 bystander position 4.5 floor-standing equipment 4.6 frequency range of interest 4.7 functional unit 4.8 idle mode 4.10 operating mode 4.11 operator 4.12 operator position 4.13 rack-mounted equipment 4.16 sound power level, Lw, in dB 4.17 sound pressure level Lp, in dB 4.19 subassembly 4.21 table-top equipment 4.23 wall-mounted equipment
ISO 5	Between heading 5 and 5.1 add: **NOTE** **DEC STD 102-4 requires a measurement of sound power level either by the procedures in this section or section 6. See section 2, Conformance.**
ISO 5.3.4	Change last sentence of the first paragraph to: All equipment shall be tested at 23 ± 1° C. Equipment, the sound pressure of which varies with temperature, shall also be tested at 27 ± 1° C. As alternatives to testing at 27° C one of the following procedures may be used: (1) test at room temperature with the fan voltage increased to the highest voltage it will see at 27° C including tolerances, or (2) calculate the fan sound power level from the measured level for the product at 23° C and from data for the fan at the corresponding voltages for 23° and 27° C. If procedure (2) is used the maximum POT correction of 5dB shall apply, and the calculation procedure shall be described in detail in the test plan.
ISO 5.4.1	General - Use of one-third octave bands is recommended.
ISO 5.5	Installation and Operation of Equipment - The following general Digital requirements are in addition to those of ISO 7779. Configuration of equipment under test: In many cases, the complexities of the equipment and the variety of the available options are such that a detailed description of the equipment under test is required. Prior to testing, according to the requirements of this standard, a detailed description of the equipment under test must be given in a test plan, equipment specification, or other documentation. The equipment under test may have its own type or model number or the same type or model number as other units with which it operates. The equipment under test shall be in good working order and in its normal operating condition, with all covers, doors, and other enclosure parts (cable opening cover plates, and so forth) in place.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 5.5.1	Equipment Installation - In the last sentence of first paragraph, replace "when labeling information is to be obtained" with "when declared noise emmission values are to be determined." Any adjustments that are required by the installation specifications to align panels, level cabinets, remove shipping blocks and bolts, etc., shall be made prior to testing. Specifically, the unit must be taken off its shipping skid or pallet. If the configuration of the equipment to be tested does not fit into any of the categories below, then it should be installed as closely as possible to the most common application(s) it will experience in customer use. a) Change "and" to "or" in first sentence of the second paragraph. Equipment Operation - Change second sentence to read: "Annex C specifies such conditions for many categories of equipment and shall be followed. However, if the conditions are clearly contrary to the objective of providing uniform conditions closely related to the intended use of the product, then an additional mode or modes closely related to intended use shall be defined, tested, and documented."
ISO 5.5.3	Add the following paragraph between the first and second paragraph of 5.5.3: "Generally an idle mode and at least one operating mode are defined. In idle mode the test unit is ready to receive and act upon data. If the unit has cooling devices they should be on. If the unit is a storage device with rotating disks, they should be rotating if this is their normal idle state. Operating modes should simulate the most common mode(s) of operation, not necessarily the loudest or worst case modes. Support equipment may be necessary for the operating mode(s). In many cases, the descriptions in Annex C may be used as guidance in defining a new mode. For example, the mode description for magnetic tape drive could be used as starting point for defining a mode for optical tape storage units until a standard specification becomes available."
ISO 5.6	Determination of Measurement Conditions - Add Caution **CAUTION** **"Discrete frequency tones" discussed in this section are not equivalent to "prominent discrete tones" determined in other sections. The sections are self-standing."** Before ISO 3742 in the second paragraph, add: "Annex A of" At the end of the second paragraph of 5.6, add: "If the reverberation room qualifies in accordance with Annex A, then the remainder of section 5.6 is irrelevant."

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 5.11.1	Equipment being tested - Replace text at a) with the following: "A complete description of the equipment under test including the model and serial number (or other unit-unique identifier, such as "Proto 2") of each unit and its principal dimensions. The Option/Module List number shall be given, for example 11780-AE, Serial Number NI00387." Add to item b): **NOTE** **Abbreviated descriptions, such as "ISO, ANSI, or ECMA test for Printers" are insufficient. If such standard tests are used, the date of the governing standard together with the complete text of the precedure followed shall be made a permanent part of the test documentation.** Replace text at c) with the following: "A complete description of the installation and mounting conditions and sketch of measurement positions." Add item f): "A Polaroid or other instant photograph of the test setup, taken from approximately 30 degrees to one side from the front at approximately 1.5 m (5 feet) height, showing the unit under test, the measurement microphone(s), and a legible sign that gives the name and Option/Module number of the unit under test. This photograph in the reverberation room is not required if one is taken in the semi-anechoic room per section 7." Add item g): "Because fan or blower noise is a major contributor to the sound level from most equipment, and because this noise can change between fans from different vendors even when they have the same Digital part number, this standard requires that, when feasible, the following fan/blower information be recorded: manufacturer, model number, and the Digital part number including the Rev number."
ISO 5.11.2	Acoustical Environment - Delete word acoustical.
ISO 5.11.4	Acoustical Data - Add to items d) and e): "or to greater precision, if available." Delete item g).
ISO 5.11.4.A	Add new section: Other Data Required (New Subhead) a. The date, time and place where the measurements were performed. The name, address, ENET address, and telephone number of (1) the Digital employee who performed the test or who supervised outside testing, (2) the person requesting the test, and (3) the person assisting the test, as delegated by the Responsible Engineer. b. A copy of typical hard copy output, of the product being tested, when applicable, should be filed as part of the recorded data. c. The test file shall contain a signed statement by the Digital engineer responsible for testing, that the measurements were performed in full conformance with ISO 7779 (with date of its issue) as modified by DEC STD 102-4 (with date of its issue).
ISO 5.12	Delete the last sentence of the first paragraph. In the note, insert "A-weighted" before "sound power." In item b) replace "LWA, in decibels" by "LNPE, in bels."
ISO 5.13	(Additional Digital requirement) Approval and archiving. Copies of all data recorded under ISO subhead 5.11 as amended shall be forwarded by the Digital person responsible for conducting or monitoring the test to the Product Acoustics Group for approval of method and for archiving. To permit further distribution of the submitted archive materials, they must be reproducible in black and white by xerographic or similar opaque copy process.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 6	Between 6 and 6.1 add: **NOTE** **DEC STD 102-4 requires a measurement of sound power level either by the procedures in this section or by the procedures in section 5. See section 2, Conformance."** Delete "ISO 3744 and", items b and c, and Note 1.
ISO 6.3.1	General - In Note 2, insert word "ceramic" before the word "tiled."
ISO 6.3.4	All modifications listed under 5.3.4 apply to the corresponding subsections of 6.3.4.
ISO 6.4.1	General - Same modification as to 5.4.1.
ISO 6.5	Installation and Operation of Equipment - General Requirements. Same modification as to 5.5.
ISO 6.5.1	Equipment Installation - same modification as to 5.5.1.
ISO 6.5.3	Equipment Operations - Same modification as to 5.5.3.
ISO 6.6.1	Add to the end of the third paragraph: For DEC STD 102-4 the hemispherical or co-axial circular paths methods of Annex B are preferred to the parallelopiped for all equipment provided the conditions of section 6.5.1 are adhered to.
ISO 6.7.1A	Delete the words: "if required". Add "Octave or one third octave band levels are required. One-third octave band levels are strongly recommended in accordance with this Digital Standard".
ISO 6.11	Information to be Recorded - All modifications listed under 5.11 apply to corresponding subsections under 6.11.
ISO 6.12	Information to be Reported - All modifications listed under 5.12 apply to corresponding subsections under 6.12.
ISO 6.13	Add new section 6.13 same as section 5.13.
ISO 7	Add between heading 7 and 7.1: **NOTE** **DEC STD 102-4 requires a measurement of sound pressure level by the procedures of this section. See section 2, Conformance.**
ISO 7.1	General. Add after last sentence with "Digital applies this method of measurement to subassemblies as well as to complete assemblies.
ISO 7.5	Add second paragraph: "Subassemblies intended for use in table top products shall be placed on the standard table and isolated from the surface by three or four elastomeric feet approximately 12 mm high, and measured for sound pressure level as table-top equipment. This includes primarily small storage devices, such as RD32, RX33, and TK70. Larger subassemblies not intended for use in table-top products are to be mounted 0.25 m above the floor on vibration isolators for sound pressure level measurements. This includes devices such as RA90.
ISO 7.6.1	Microphone Positions at the Operator Position. Add the following new paragraph: For equipment that requires a keyboard for operation, such as PCs or VDUs, the reference box should allow room for the keyboard whether or not it is present during the test. If the keyboard dimension is not known, a default value of 0.25m shall be used.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 7.6.2	At the bystander position. Delete first sentence. Modify second sentence to read: "At least four bystander positions shall be specified whether or not operator positions are specified." Add to the end of the first paragraph of 7.6.2: "For equipment that requires a keyboard for operation, such as a PC or VDU, the reference box should allow room for it whether or not it is present during the test. If the keyboard dimension is not known, a default value of 0.25 m shall be used."
ISO 7.7.2	Change "6.7.2" to "5.7.2".

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 7.7.5	Add the following new section: High Frequency Noise in 16 kHz Octave Band - For the operating and idle modes, the following procedure shall be used to determine the presence, frequency, and sound pressure level of discrete tones or narrow band noise present in the spectrum in the 16 kHz octave band. For equipment that requires an operator, use the microphone position specified in ISO 7.6.1. For equipment that does not require an operator, use the bystander position specified in ISO 7.6.2 with the loudest A-weighted level as determined by the analysis required in ISO 7.7.1. Orient the microphone such that its frequency response is flat to 20 kHz for sound incident from the centroid of the unit under test. Measure the sound pressure level in the frequency range from 11.2 to 22.4 kHz with a filter no wider than 1/10 octave, plotting the output on a chart recorder or other output device that permits inspection of the entire frequency range. Examine the output for indications of a discrete tone. Particular attention should be directed at the power supply switching frequency and the raster frequency (for visual display units, often approximately 15.7 kHz). Examine the output in the 16 kHz octave band for discrete tones or narrow band noise. Also, if one-third octave band data was obtained during the measurements specified in ISO 7.7.1., examine this data. This standard does not present formal criteria, but the following guidelines can be used to screen for the presence of discrete tones and/or narrow band noise: 1. the level of one or more bands in the one-tenth octave band (or narrower) analysis, in the frequency range from 11.2 to 22.4 kHz, exceed the level in either adjacent bands by 5 dB or more, and/or 2. the levels of one or more one-third octave bands that make up the 16 kHz octave band are within 10dB of the highest one-third octave band levels below 11.2 kHz and exceed the background noise level by more than 3 dB. If neither of the screening testes indicate high frequency noise, no further work is required per this subhead. If screening test (2) indicates the presence of high frequency energy, then a measurement of high frequency sound power level shall be made in accordance with ISO 9295. If screening test (1) indicates the presence of high frequency tone or narrow band noise at the operator or bystander position, then a measurement of sound pressure level shall be made using the following procedure: The filter shall be adjusted to the frequency of each tone detected, and the microphone shall be moved slowly in a regular pattern consisting of at least 6 linear traverses spaced over a 0.25 m2 area centered at the original microphone position and parallel to the closest face of the reference box. The displayed time history of the level of filtered sound pressure shall be inspected. An alternative to sweeping the microphone is to use a number, n, of equally spaced microphone positions over the 0.25 m2 area. The value n shall be at least 5 and greater than the range in decibels of the measured tonal sound pressure level among the n positions. The range, logarithmic (or "energy") average value, and frequency shall be recorded, and the average value shall be reported. Two (faster) alternative procedures that lead to more conservative (higher, potentially less acceptable values) are: to perform the spatial scan using a 16 kHz octave band filter or; to perform one scan for each of the one-third octave bands centered at 12.5, 16, and 20 kHz. As previously, frequency and average sound pressure level value shall be logged, and be reported.
ISO 7.9	Information to be Recorded - All modifications listed under 5.11 apply to corresponding subsections under 7.8.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO 7.9.4	In item e) delete the word "optionally." Add new item h): "For each operating mode, for the operator position, if defined, otherwise for bystander position with the highest A-weighted sound pressure level, a magnetic tape recording, Philips cassette format, of duration at least one minute, annotated by voice on the second track with the name of the product, the test mode, the microphone position, and the A-weighted sound level of the signal. Dolby or other magnetic tape noise reduction features shall NOT be used. This standard does not require that a calibration signal be recorded. The bias used in recording shall be noted on the cassette." New item i) - The result of the test for High Frequency Tones (See amended Section 7.7.7), specifically: bandwidth of analyzer, and frequency and sound pressure level of any tones detected.
ISO 7.10	Test Report - All modifcations listed under 5.12 apply to corresponding subsections under 7.10. Insert in first paragraph after standard "as modified by DEC STD 102-4." Item b) delete: "if an operator position is defined according to 7.6.1," - Item c) delete: " if bystander positions are defined according to 7.6.2."
ISO C.3.3.3	Add the following note after the first paragraph: Note: For printers whose noise level is independent of the print pattern (e.g., laser printers) it is not necessary to the pattern specified below. In such cases a more convenient pattern, such as an internal test pattern, may be substituted.
ISO C.8.3.3.2	Add to the end of sentence: "or reading."
ISO C.9.3.2.3	Additional Digital Requirement Flexible Disk Units for random access use. Random Read/Write - Random selection of the cylinders to be sought. Read or write all sectors of all tracks on each cylinder sought out. No intentional delay at any cylinder after Reading/Writing has been finished.
ISO C.10.1	Replace Notes 1 and 2 by: Note: DEC STD 102-4 excludes sound power and sound pressure levels in the 16kHz (11.2 to 22.4 kHz) octave band in the determination of A-weighted levels in accordance with Sections 5, 6 and 7 of ISO 7779. For this octave band only, two screening tests shall be performed in accordance with the DEC STD 102-4 modifications to section 7.7.5 of ISO 7779. If the screening tests indicate the presence of high frequency sound energy, then additional tests are required as specified in the revised 7.7.5.
ISO C.11	Add the following new section from ECMA-74:
ISO C.11	Equipment Category - Personal Computers and Work Stations
ISO C.11.1	Description - Small systems such as personal computers, work stations and word processors, which include a keyboard, visual display unit, and a processor unit which itself may contain combinations of one or more flexible disk and/or rigid drives, magnetic tape units or printers.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO C.11.2	Installation - The constituent units of the system may be tested individually and reported accordingly. In this case the installation conditions are as in 5.5.1, 6.5.1 and the relevant clauses of Appendix C of this Standard. Alternatively the equipment may be tested as a complete system. In this case for the measurement of sound power levels the equipment shall be mounted on the hard reflecting floor and the orientation used recorded. For the measurement of bystander and/or operator sound pressure levels, the separate enclosures shall be arranged in a set-up that is typical of actual use. Table top equipment shall be tested on the Standard Test Table. If some of the separate enclosures are floor-standing equipment and others are table-top equipment, the floor-standing equipment shall be installed next to the Standard Test Table on the left or right of the table and the table-top equipment installed on the Standard Test Table.
ISO C.11.3	Operation - Idle Mode - Power shall be switched on, the equipment shall be in a steady state condition, with air moving device(s) running, disk drives in the idle mode, a full character set displayed on the screen and all other devices idling. Noise due to keyboard operation shall not be included. Operating Mode(s) - One or more of the following operating modes shall be used where applicable: Equipment with disk drives as C9. In combinations of rigid and flexible disk drives the operating mode giving the highest level shall be used. Equipment with magnetic tape units as C8. Equipment with built-in printers as C3.
ISO C.11.4	Measurement duration - The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 and 6.7.2.
ISO C.12	Add the following new section:
ISO C.12	Equipment Category: Optical Disk Storage Devices
ISO C.12.1	Description - Optical disk storage units: Equipment used for data storage using one or more rotating disks for optical decoding. Includes CDROMs as well as WORMs (write once, ready many) units.
ISO C.12.2	Installation - Installation shall be in accordance with the relevant clauses of this International Standard.
ISO C.12.3	Operation -
ISO C.12.3.1	Idle Mode - Disk loaded, power on, unit ready to receive and respond to control line commands to any drive. In multiple drive units all drives shall be loaded and ready.
ISO C.12.3.2	Operating Modes - One of the modes outlined in C.12.3.2.1 or C.12.3.2.2 shall be used, as applicable.
ISO C.12.3.2.1	Random access files - Random selection of a file of typical length. Read or write the selected file. This process to be repeated continuously, with no intentional delays between files, until data at all measurement positions is obtained.
ISO C.12.3.2.2	Sequential access files - Sequential selection of the cylinders starting at track 0 and then proceeding to tracks 1, 2, 3, . . ., N and repeating as required. Read or write on all sectors of each track. No intentional delay at any track after reading or writing has been finished.
ISO C12.4	Measurement duration - The time-average sound pressure shall be measured for at least the duration specified in 5.7.2 and 6.7.2
ISO C13	Equipment Category: Noise Reduction Products
ISO C13.1	Description - This category covers all products that are designed to reduce the acoustic noise emissions of other (base) products. Examples are: (a) an acoustic enclosure for a desktop printer, and (b) a muffler for an air moving device, if the muffler is an optional part.

ISO 7779 HEADING	DIGITAL DIFFERENCE
ISO C.13.2	Installation - The base product (e.g., the printer in example (a) above) with and without the noise reduction product shall be installed in accordance with the installation clauses of ISO 7779 for the base product.
ISO C.13.3	Operation - The base product shall be tested at the proper idle and operating modes for it, with and without the noise control product in place.
ISO C.13.4	Measurement Duration - The time-average sound pressure shall be measured for at least the duration specified in 5.7.2 and 6.7.2.
ISO Annex D	This Annex is an integral part of DEC STD 102-4.
ISO D.1	Add after end of first sentence: The prominent discrete tone analysis is limited to the frequency range from 89.1Hz to 11.2kHz.
ISO D.4.2	Add items c) and d) as follows: c) the sound pressure level of secondary tones in the critical band; d) the fundamental frequency of harmonic series.
ISO D.4.3	Replace second sentence with: This listening shall be conducted by each of the following procedures: (1) Conduct a general listening test without any comparison to reference tones, if the test item sounds tonal, the following procedure shall be performed for any such tones. (2) After performing the following procedure at any tone that appears to be prominent in the narrow band analysis, play this tone over a headset or speaker and compare it to the noise from the product noting whether or not that tone is audible in the product. Add before the last sentence of the text (not in notes): The filter bandwidth used to determine the level of the discrete tone should not exceed ten percent of the critical bandwidth as defined in section D.4.4.
ISO D.4.6	Replace the entirety of D.4.6 by: The noise emitted by a machine may contain many tones, and several of these may fall within the same critical bandwidth. For these cases, DEC STD 102-4 requires two evaluations: (1) Do not treat addition tones any differently than the remaining noise in the critical bandwidth. That is other tonal components that are contained within the critical band around the primary tone are considered to be part of the masking noise, and are included in the determination of Ln. (2) Do not include a strong secondary tone in the critical bandwidth as part of the masking noise. That is, the measured masking noise Ln of the critical band around the primary tone being evaluated should exclude the sound energy from the second highest tone in this band.
ISO D.4.7	Insert the following subhead between the present heading and the text: D.4.7.1 Required ISO procedure Add the subhead and text to the end of D.4.7: D.4.7.2 Additional Digital required procedure: Evaluate all tones in harmonic series independently as any other discrete frequency sound.
ISO D.7	Add new section:
ISO D.7	Reporting of prominent discrete tones - For each discrete tone that computes as prominent, report the following: a. the frequency of the tone b. the amount by which Lt exceeds (Ln + 6dB) using the procedure specified in D.4.6 (1). c. the amount by which Lt exceeds (Ln + 6dB) using the procedure specified in D.4.6 (2). d. Whether or not the tone is highest A-weighted sound pressure level in a harmonic series.

APPENDIX A LAB REQUIREMENTS

A.1 OVERVIEW

Digital maintains a qualified acoustics lab in Maynard, but at times it may be appropriate to test elsewhere. If a 102-4 test is to take place at an outside lab it must be conducted in conformance with the body of this standard, in a qualified lab and with the proper tasks performed by the responsible engineer and the Product Acoustics Group.

Since it may be difficult to wade through the entire standard (including ISO 7779) to see if an outside lab is qualified to do the test, this appendix provides the Responsibile Engineer with a check list of the major testing capabilities that are required by this standard. This list can be used as a first order screening test to see if a specific lab has the potential to qualify. If the lab passes this screening test then a more detailed accessment of the lab's qualifications should be made by comparing the labs capabilities with the requirements of the entire standard.

This appendix also provides an synopsis of the the responsibilities of (a) the Product Acoustic Group and (b) the Responsibile Engineer when the testing is conducted outside Digital.

In all cases if there is a conflict between the material in this apppendix and the body of the standard, the body of the standard shall govern.

A.2 LAB REQUIREMENTS

The test lab must have at least the following capabilities:

- A semi-anechoic room that qualifies for precision grade measurements per ISO 3745 with a background noise level that is at least 6 dB lower than the A-weighted sound level of the product. Sound power level measurements can also be made in conformance with ISO 3742.
- The lab should meet the qualification requirements of NVLAP accrediation [A1].
- A test enviromnent held to 23° C ± 1° C during the test, and the cabability making measurements at 27° C ± 1° C if the product has fan speed control. (Simulating higher temperature fan operation is also allowed.)
- A sound level meter or microphone/analyzer combination which qualifies as a Type 1 per IEC 651, with A-weighting and octave band filters (one-third octave preferred). Also it shall be equipped with Impulse meter characteristics.
- A narrow band analyzer with a bandwidth resolution of less than one percent of any frequency from 89 Hz to 11.2 kHz for prominent discrete tone analysis.

A.3 RESPONSIBILITIES OF RESPONSIBILE ENGINEER

Some of these items are a sub-set of those listed in Section 1.4.1, but rewitten with the persepctive that the test will be conducted outside Digital. Other items are included to make the process run in an orderly manner.

- Make sure that the product can be run in the required test modes at the lab under consideration.
- Develop a test plan and submitt it to the Product Acoustics Group for review at least four weeks in advance of the test.
- If this is the first time a DEC STD 102-4 test is to be run at a specific lab, the Product Acoustics Group shall be informed at least four weeks in advance so they can send an observer.
- Insure that the lab tests and reports on the product are in accordance with the requirements this standard.
- Provides copies of the test report to the Product Acoustic Group for archiving.

A.4 RESPONSIBILITIIES OF THE PRODUCT ACOUSTICS GROUP

Some of these items are a sub-set of those listed in Section 1.4.5, but rewitten with the persepctive that the test will be conducted outside Digital. Other items are included to make the process run in an orderly manner.

- Provides product groups with interpertations of the standard at their request.
- Review all acoustic noise emission test plans, and approve them when they satisfy the requirements of DEC STD 102-4.
- Attend first time 102-4 tests at new facilities.
- Recieve and archieve test reports and data.

A.5 REFERENCES

National Voluntary Laboratory Accredation Program (NVLAP); Formal Establishment of Acoustics Laboratory Accredation Program, FR v.47, no.176, 10 Sept. 1982, pp. 39874-39878.

APPENDIX B TEST PLAN REQUIREMENTS

This standard requires the Resonsible Engineer, or his desiginate, to develop a test plan prior to the testing of the product. When the testing is conducted at the Product Acoustics Lab this plan is generally developed jointly by the Responsible Engineer, or his desiginate, and a representative of the Product Acoustics Group. A test plan must be submitted to the Product Acoustics Group for approval whether or not the product will be tested at the Product Acoustics Lab.

The test plan shall contain at least the following information:

1. The product option module number including the class code (e.g., RF-) if applicable, and the variation code (e.g., -AB) which differs depending on configuration and line frequency.
2. The name of the responsible engineer and, if he will not directly support the testing, the name of the person he assigns to support the testing.
3. The option modules numbers of other units not tested but intended to be covered by this test.
4. The product manufacturer, DEC or external vendor.
5. The status of the samples to be tested (e.g. engineering model, production)
6. The product description including:
   a. What it is (e.g., hard disk drive)
   b. What it contains (e.g., PC with two RD54s and one TK70), and how its subassemblies are arranged
   c. How it will be installed at customer locations (e.g., on a table, on the floor, and so forth)
7. A description of the operating modes defined for this product (per DEC STD 102-4, haeding 4), and for each operating mode the following:
   a. If this is an operator attended mode
   b. Mode type (idle, operating disk, operating)
   c. If the product fills its end-use enclosure for the mode as defined in DEC STD 104
   d. The test temperature for the mode (low, high or both –products with fan speed control shall be tested at low and high temperature) Note: tests modes shall be selected inaccordance with heading 4 of this standard, and should be sufficient to quantify all saleable configurations of the product.
8. A list of those who will receive the test report, including their mail addresses and E-Mail nodes if applicable.

APPENDIX C REFERENCED DOCUMENTS

C.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00005-02	*DEC STD 005-2 Reporting Products Potentially Non-Compliant with Digital Design Standards*
EL-00007-00	*DEC STD 007-0 Design Review Process*
EL-00028-00	*DEC STD 028-0 Phase Review Policy*
EL-00066-02	*DEC STD 066-2 Waivers to Digital Design Standards*
EL-00104-00	*DEC STD 104-0 Product Acoustic Noise Limits*
EL-CP356-00	*Corporate Phase Review Process Guide*
EL-EN522-00	*Digital Qualification Process Manual*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 287-3724.

C.2 Other Documents

Document Number	Document Title
ANSI S1.1-1960(R1976)	*Acoustical Terminology*

C.3 Ordering Information

Following are the sources for documents not available from Standards and Methods Control.

- American National Standards Institute (ANSI),
  1430 Broadway, New York, NY 10018,
  Telephone (212) 354-3300 x479

GLOSSARY

The terms used in this standard conform to those used in ANSI S1.1-1969 and ISO 7779. Reference values for acoustical levels are given in System International (SI) units in accordance with ANSI S1.8-1969.

NOTE

Whenever the definition of the term is followed by an asterisk (*), the definition has been quoted directly from ISO 7779. Occasionally, the quoted portion is followed by examples of Digital products, or by a more restrictive definition of the term.

NOTE

For correct understanding and use of this standard, it is important to understand the terms immission, emission, sound pressure level, and sound power level.

A-weighted sound pressure level (LPA) in decibels: The frequency-weighted value of the sound pressure level determined with a sound level meter set for the A-weighting filter network conforming to IEC 651. The filtering characteristics approximately simulate human hearing frequency response.

Throughout this document subscripting of level quantities has been eliminated, for example, LPA will be represented as LPA.

A-weighted impulse sound pressure level (LPAI) in decibels: The A-weighted sound pressure level determined with a sound level meter set for the dynamic characteristic impulse. Note: In this standard, the LPAI is 10 times logarithm to the base 10 of the time average over the measurement period of 10 raised to the power of the meter reading.

bel: A unit of level. (In this standard, used exclusively as a measure of Noise Power Emission Level. Thus, the quantity Log (W/Wo) has units of Bels, where W is emitted acoustic power and Wo is 1 picowatt.)

bystander: An individual who is not the operator of the equipment, but whose position lies within the sound field produced by the equipment, either occasionally or continuously.*

bystander position: A measurement position at a typical location occupied by a bystander.* A location 1.50 meter above the floor and 1.00 meter away from the equipment, unless otherwise specified herein.

decibel: One-tenth of a Bel. (In this standard, used primarily as a measure of Sound Pressure Level.)

declared noise emission value: The value of the declared A-weighted sound power level, LwAd, or that of the declared A-weighted sound pressure level, LpAm, or both, per ISO 9296. LwAd is a statistical maximum value. (The Swedish Statskontoret 26.1 requires declared noise emission values.)

designated noise emission value: The arithmetic mean of the values of the A-weighted sound power level, LwAm, or that of the A-weighted sound pressure level, LpAm, or both.

discrete tone: A sound whose energy is concentrated at a single frequency, or within a very narrow frequency band, and which is generally louder than adjacent broadband noise. A narrow band analyzer may be required to determine if a discrete tone is present. When a discrete tone is present, the amplitude of the filtered signal in a small number of bands will remain relatively constant as the filter bandwidth is decreased. In contrast, the amplitude of broadband noise, at frequencies not containing tones, will decrease in proportion to the filter bandwidth as the bandwidth is decreased.

emission (pronounced EEE-mission): The sound radiated by a specific source. Emission is determined under special test conditions, considered to exclude noise from other sources. The emission quantities to be determined according to DEC STD 102-4 are A-weighted sound pressure level at a specific location relative to the source, noise power emission level, presence or absense of impulsive noise or prominent discrete tones, and frequency, sound pressure and sound power level of tones in the octave band centered at 16 kHz.

end-use enclosure: The outermost enclosure as seen by the customer in an end-use application. The exterior surface of this enclosure is accessible by the customer when the product is installed and operating normally. It may comprise both product-specific surfaces (for example, bezels or top-doors) and cross-product surfaces (for example, side skins, bottom panel, rear doors), or it may be entirely product specific (for example, VT340).

floor-standing equipment: A unit that has its own stand and is intended to be installed on the floor.* (Examples: MicroVAX 3500, VAX8550.)

frequency range of interest: This range normally extends from the 100 Hz one-third octave band to the 10,000 Hz one-third octave band. The 16 kHz octave band shall be included when a preliminary investigation indicates that it may affect the A-weighted sound pressure or sound power levels [or exceed the DEC STD 104 high frequency tone limits.] Range and center frequencies of the octave bands are specified in ISO 266.*

NOTE

If the 16 kHz octave band is included in the measurements, the procedures of the ISO standard may yield measurement uncertainties greater than those stated.* This Digital Standard prescribes Digital-unique procedures to handle this octave band.

functional unit: An entity of physical equipment that has been allocated an identification number, capable of accomplishing a specified task. A functional unit may be supported by a frame or frames and may be self-enclosed or designed to be attached to another device.* It shall be contained within only one cabinet or a set of cabinets which are always present in the same configuration.

high frequency tone: A tone having its frequency lying within the 16 kHz octave band (11.3 kHz to 22.4 kHz).

idle mode: A condition in which the equipment being tested, after any necessary warm-up period, is energized but is not operating,* that is, not performing useful work.

immission (pronounced EYE-mission): The noise exposure received over a time period in a given environment; specifically it is sound pressure level, during the time of measurement, at the ear of an observer. In general, immission is caused by a variety of acoustic noise sources, near and far: the building air conditioning system, a ringing telephone, conversation in an adjacent office, a truck passing by outside, and the fan-cooled intelligent terminal on the observer's desk. Immission is measured on-site, in the work place. The quantity to be determined is always sound pressure level at a defined location, for a specific time; not sound power level.

NOTE

This standard applies to emission measurements on products and not to immission measurements on environments.

impulsive noise: A short burst or series of bursts of acoustic energy consisting of either a single event or a series of events, as determined in accordance with relevant section(s) of DEC STD 102-4.

level (of a quantity): The common (base 10) logarithm of the ratio of that quantity to a reference quantity of the same kind. The reference quantity and the kind of level must be specified in this document. For example, LP is sound pressure level; LNPE is noise power emission level. The reference quantity for sound pressure is always 20 uPa; for sound power, 1 pW.

noise power emission level (LNPE): The A-weighted sound power level in Bels. The reference sound power is 1 pW. Noise power emission level is a measure of the total sound energy per unit time radiated in all directions by the test unit and is independent of the room where the measurement is done. The noise power emission level is preferred to other measures of total radiated sound energy because the level is numerically very different in value from other numbers associated with product noise, and the difference helps to avoid confusion.

octave band: A frequency band having its upper frequency limit twice its lower limit. Current practice is to identify a band by its geometric center frequency. For further discussion, see ISO 266.

operating mode: A condition in which the equipment under test is performing its intended function(s).*

operator: An individual who operates a piece of equipment from a position in the immediate vicinity of the equipment.*

operator position: Measurement position at the assigned workstation of the operator, * located as follows (unless otherwise specified herein): (1) 1.50 m above the floor (standing operator), or (2) 1.20 m above the floor (seated operator/floor-standing equipment). The horizontal distance from the front edge of the reference box to the microphone is 0.25 m.

NOTE

ISO uses the term "workstation" to mean assigned station for work, not a workstation unit, for example, a standalone computing system.

prominent discrete tone: A discrete tone whose level is 10 dB or more above the level at which the discrete tone would be just audible, as determined in accordance with relevant sections of DEC STD 102-4.

rack-mountable equipment: See Subassembly.

rack-mounted equipment: One or more Subassemblies installed in an end-use enclosure.* (Example: RF30 installed in a BA215.)

reference box: A hypothetical reference surface which is the smallest rectangular parallelopiped that encloses the equipment being tested and terminates on the reflecting plane.

sound power level (LW) in decibels: Ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power. The weighting network (A-weighting) or the width of the frequency band used shall be indicated. The reference sound power is 1 pW.

NOTE

In this standard, the sound power is the time average value of the sound power during the period of measurement duration.*

When the sound power level is A-weighted and expressed in bels, it is called the Noise Power Emission Level.

sound pressure level (LP) in decibels: Ten times the logarithm to the base 10 of the time-mean-square the sound pressure to the reference sound pressure. The weighting network (A-weighting) or the width of the frequency band used shall be indicated. The reference sound pressure is 20 uPa.

NOTE

In this Standard the sound pressure is the square root of the time average of the squared sound pressure during the measurement duration.*

NOTE

Sound pressure levels measured in installed conditions at the customer site usually differ from those measured in accordance with this Standard in the laboratory. This is because sound pressure level and A-weighted sound pressure level characterize the *sound field* at a single point in space *due to all causes.* All distinct noise sources, background noise, and the acoustical properties of the surroundings, such as reflectivity and absorptivity of nearby surfaces, affect this quantity. In contrast, sound power level and Noise Power Emission Level characterize the *outflow of sound energy per second* from an *emitting source* only, and is relatively independent of the surroundings.

subassembly: A functional unit intended to be installed in another unit or assembled with other units in a single enclosure. The unit may or may not have its own enclosure.* Examples: RF30, RX33.

table-top equipment: A functional unit that has a complete enclosure and is intended to be installed or used on a table, desk, or separate stand.* For example, VT340, LA75.

wall-mounted equipment: A functional unit which is normally mounted against, or on a wall and does not have a stand of its own.*